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D&S Technical Note 11-3

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A Proposed Correction to Emittance Measurements of Profiled Surfaces

Introduction

For a profiled or extruded surface such as clay roofing tiles or metal roofing, measurement of emittance with the D&S Model AE1 Emissometer is limited to obtaining the property of the surface as if it were flat. The actual or “aggregate” emittance will be higher than the surface emittance. Typical profiled surfaces for construction use do not have severe geometries and therefore the difference between the surface emittance and the aggregate emittance will be small. If the difference is small and a correction can be estimated based on the geometry of the surface, the measurement of the surface emittance can be used to estimate the aggregate emittance of a profiled surface.

Emittance Calculation

A proposed correction for solar reflectance measurements of profiled surfaces is described in D&S Technical Note 09-2 (ref (1)). A similar approach is used here to calculate a corrected emittance value. The calculation is based on a net-radiation method described in reference (2) page 250 which breaks the surface into finite pieces for analysis and assumes diffuse emittance and reflectance. For the calculation of emittance the profiled shape is treated as an isothermal heated surface with a “top” that has an emittance of 1.0. The aggregate emittance of the profiled shape is proportional to the heat flow to the fictitious top surface. Calculations were made for three common profiled shapes shown in Figure 2.

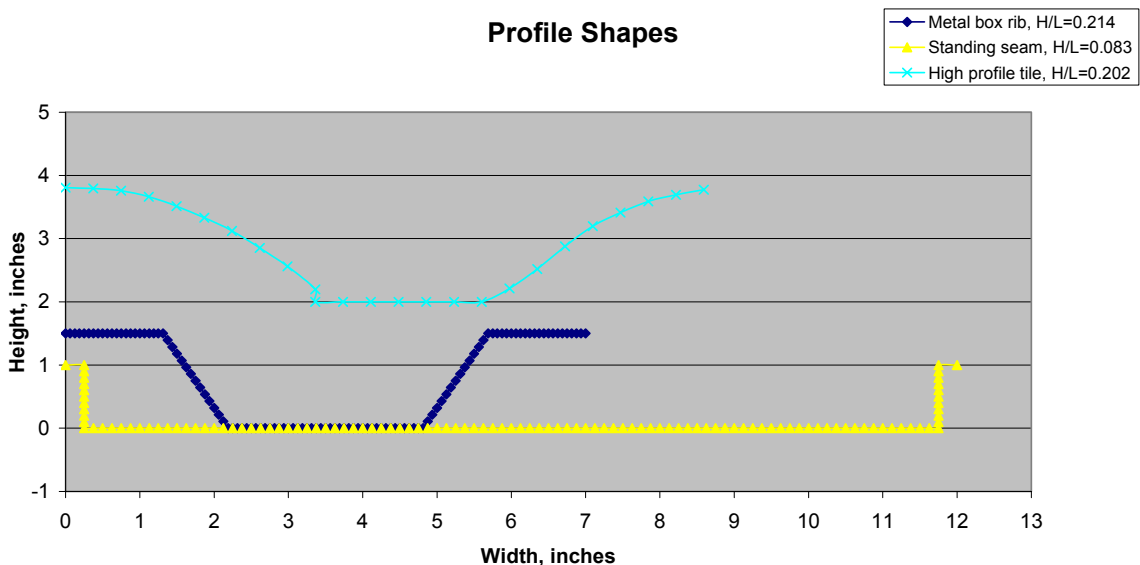
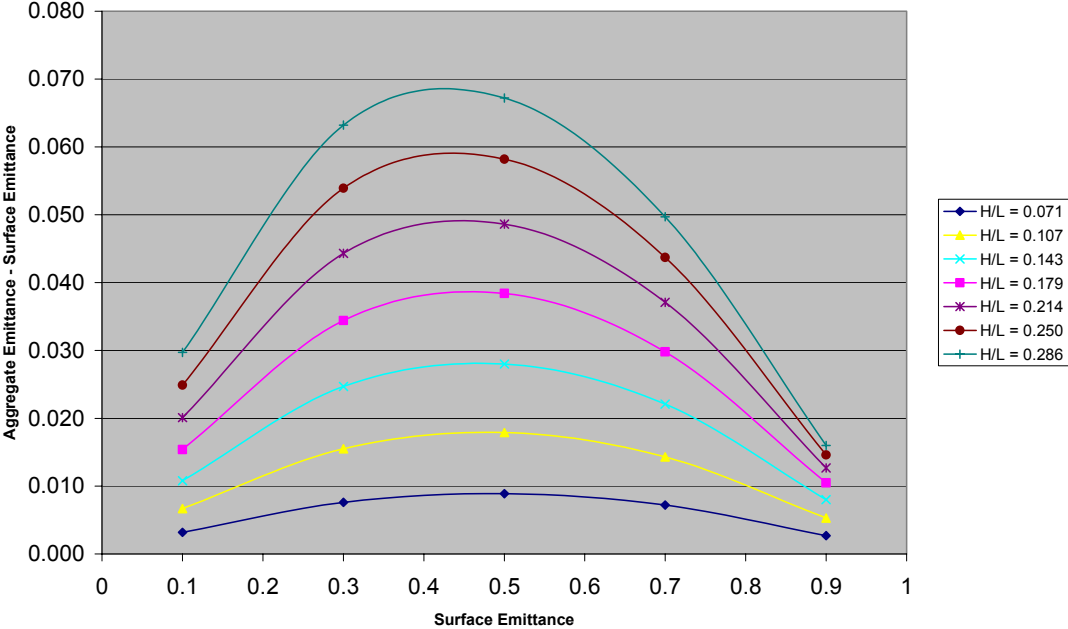


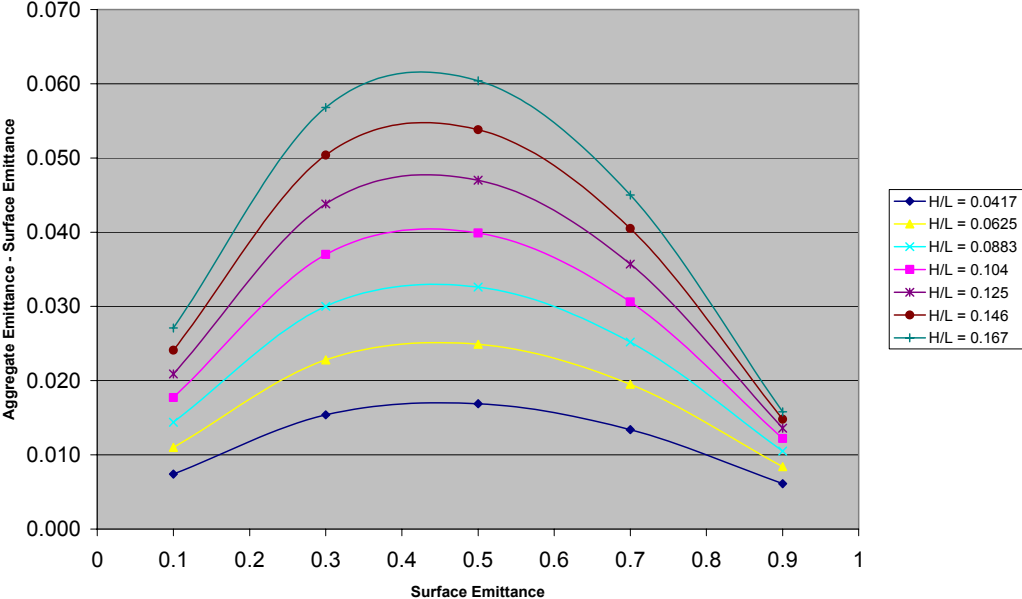
Figure 2. Profile Shapes divided into finite elements for emittance calculation.

Figure 2 shows the actual profile shapes roughly to scale along with the endpoints of the finite element segments. The parameter H/L is the height divided by the length of one full cycle of the profile. The plots in Figure 3 were created by scaling the profiles to different values of H/L and calculating the aggregate emittance for different surface emittance values. The H/L values range to at least twice that of a typical profiled shape.

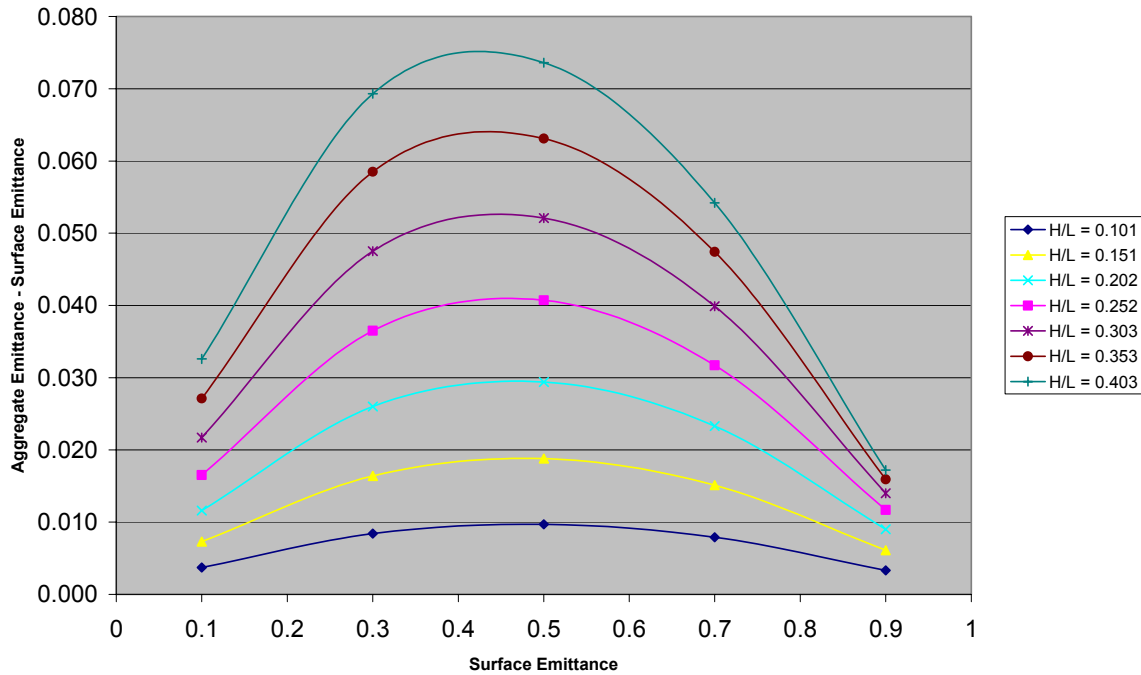
Metal Box - Aggregate Emittance Correction



Standing Seam - Aggregate Emittance Correction



High Profile Tile - Aggregate Emittance Correction



Similar to the correction for reflectance as shown in D&S TN09-2, the correction for emittance is a strong function of surface emittance and is largest in magnitude at a value of about 0.50. This is explained by the fact that some of the emitted radiation restrikes the surface and a portion of that amount will be reflected.

$$E_{\text{aggregate}} - E_{\text{surface}} \approx k * E_{\text{surface}} * (1 - E_{\text{surface}})$$

This expression is a maximum when E_{surface} is 0.5.

References:

- (1) D&S Technical Note 09-2, A Proposed Correction to Reflectance Measurements of Profiled Surfaces
- (2) "Thermal Radiation Heat Transfer", Siegel and Howell, McGraw-Hill Book Company, 1972.
- (3) D&S document "S:\SOLAR\SSR\Profile Aggregate Reflectance Correction.xls"
- (4) D&S source code "\qbasic\profile.bas"